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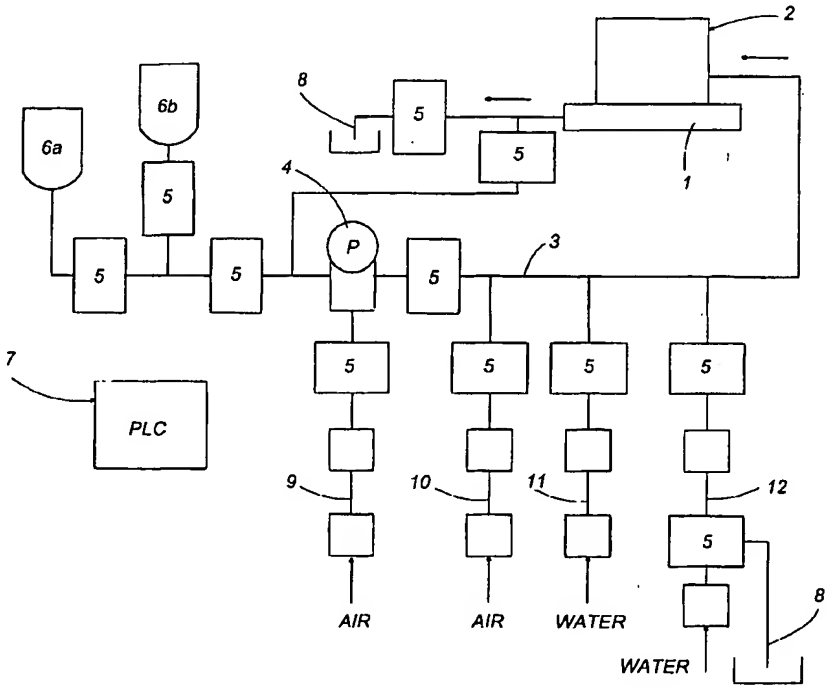
(54) A process for the functional regeneration of the porosity of moulds used for moulding ceramic objects

(57) A process for the functional regeneration of the porosity of the materials used to make moulds (2) for moulding ceramic objects, said porosity being damaged by use of the mould (2), comprises the sequential execution of at least two successive steps of an ordered sequences which includes the steps of: eliminating contamination caused by organic substances from the mould (2); eliminating contamination of biological origin from the mould (2); attacking inorganic encrustations and eliminating inorganic substances which have infiltrated the porosity of the mould (2), the initial step of the process being preset according to the nature of a predetermined contaminating agent. A station implementing the process is also an integral part of the present invention.

FIG.4



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Description

[0001] The present invention relates to the production of ceramic objects, in particular plumbing fixtures, the objects moulded by casting a ceramic mixture (known as *slip*) into moulds made of porous, draining materials. In particular, the present invention relates to a process for treatment to restore the porous functionality of the material of which the moulds are made, which becomes blocked as a result of using the moulds.

[0002] Moulds made of porous material for the production of ceramic objects comprise one or more forming cavities, each delimited by a surface designed to form the outer surface of the ceramic object and connected to a network of drainage channels and a system for filling the forming cavity with the ceramic mixture and emptying the cavity. Special drainage manifolds and slip manifolds allow access respectively from the outside of the mould to the drainage channel system and to the mould forming cavity filling and emptying system.

[0003] Functionally, the above-mentioned moulds may be considered on a level with a draining filter in which the ceramic mixture, cast in the forming cavity in the form of a water-based suspension of extremely fine solid particles, is held and moulded, whilst the liquid fraction separates from it through the surrounding forming surface which acts as a filter screen.

[0004] In practice, such moulds are controlled by a machine which controls the moulding cycle. At particular steps of the cycle, the mould drainage system may be supplied with the so-called service fluids (water, air and washing solutions). These may be supplied in two ways, that is to say, against the current or by absorption. When supplied against the current, the service fluids are introduced into the drainage system by means of the drainage manifolds, then flow down into the forming cavity, passing through the forming surfaces. During supply with absorption, with the flow parallel with the current, the service fluids are applied on the forming surfaces and left to migrate towards the drainage system by gravity or with the aid of a vacuum.

[0005] In the plumbing industry, the raw materials used for the ceramic mixtures, that is to say, the slips, are inorganic, obtained as a result of industrial refinement or directly from natural deposits. In the latter case, they may, therefore, contain impurities due to organic substances or other mineral compounds.

[0006] Slips normally consist of clays, feldspar and silica, finely ground and dispersed in water, of the industrial type. The solid particles in these ceramic mixtures have diameters measuring between several fractions of a μm up to around 40 μm.

[0007] Therefore, if, during use, a mould made of porous material (for example, a mould made of microporous resin) is not subjected to targeted and regular maintenance treatments, the porosity may be partially or completely blocked, due to the natural penetration of particles from the ceramic mixture, or the infiltration of impurities from the air and/or water used for mould operation. Moreover, the filter layer of a mould may also accidentally be damaged by contamination by substances from outside the production cycle, such as greases, oils, etc.

[0008] The effects of the substances infiltrating the porosity of the mould filter screen may be classed as: biological and organic contamination; inorganic encrustations; and mixed encrustations, which combine the various types indicated above.

[0009] In the case of biological contamination, the contaminating agents are the impurities contained in the mixtures or in the mould service water, such as humus and bacterial loads in general.

[0010] As indicated, organic contamination is due to the accidental presence of greases and/or oils.

[0011] Contamination by encrustations is due to the formation of clusters as a result of the interaction of particles in the mixture with salts or oxides. The latter may be present as impurities in the raw materials and/or in the water used to prepare the mixture, or may be introduced into the mould during the various steps of the technological cycle (for example, with water during mould washing).

[0012] At present there are no known processes for regeneration of the mould materials which allow the full restoration of the original microporosity of the material. Therefore, there is no remedy to the progressive deterioration in the functionality of moulds made of resin, with consequent deterioration of production conditions in the specific steps of the process in question (object forming and removal from the mould). For these reasons, after a given period of use, the moulds must be substituted.

[0013] The aim of the present invention is to introduce a process for regeneration of the functionality of the porosity of the materials in which the various operating steps are carefully chosen and ordered in a preset sequence, using methods which allow the systematic and complete elimination of the various contaminants and, at the same time, allow everything to be done with a high level of efficiency which guarantees a significant extension of the useful life of the moulds.

[0014] Accordingly, the present invention achieves said aim with a process for the functional regeneration of the porosity of the materials used to make moulds for moulding ceramic objects, damaged by use of the mould. The process is characterised in that it comprises the sequential execution of at least two successive steps of an ordered sequence which includes the steps of eliminating contamination caused by organic substances from the mould, eliminating contamination of biological origin from the mould, attacking inorganic encrustations in the mould, eliminating inorganic substances which have infiltrated the porosity of the mould, said process having a preset initial step which depends on the nature of a predetermined contaminating agent.

[0015] The order of the steps in the process surpris-

ingly revealed a synergic enhancement of the effects produced by the individual steps which, by extending useful mould life, allows significant savings in terms of installation and operating expenses.

[0016] The technical features of the present invention, in accordance with the above-mentioned aims, are set out in the claims herein and the advantages more clearly illustrated in the detailed description which follows, with reference to the accompanying drawings, which illustrate a preferred embodiment without limiting the scope of application, and in which:

- Figure 1 is a schematic illustration of a first sequence of steps in the regeneration process, in which the porosity of the mould material affected by organic contamination is regenerated;
- Figure 2 is a schematic illustration of a second sequence of steps in the regeneration process, in which the functionality of the porosity of the moulds affected by inorganic and biological contamination is regenerated;
- Figure 3 is a highly schematic representation of a regeneration process suitable for regenerating porosity affected by mixed contamination;
- Figure 4 is a layout diagram of an operating station in which the process in accordance with the present invention is implemented.

[0017] Figure 3 of the accompanying drawings illustrates as a whole a functional block diagram of a mould treatment process, for moulds made of a porous material, for moulding ceramic objects. The process is designed to restore the original functionality of the porosity of the material, damaged by repeated use of the mould.

[0018] The process involves the sequential, non-commutative execution of successive steps of an ordered sequence which, as a whole, includes steps of: eliminating contamination caused by organic substances, eliminating contamination of biological origin, attacking inorganic encrustations to cause their flaking, and using fluidification to eliminate inorganic substances which have infiltrated the pores. The first of these steps is symbolically represented in block A in Figure 3 and in the sequence in Figure 1. The second, third and fourth steps are symbolically represented with block B in Figure 3 and with the sequence in Figure 2.

[0019] The complete ordered sequence described above involves the systematic treatment of all the types of contamination which can normally affect a mould made of microporous resin for the production of ceramic objects, preferably plumbing fixtures. However, if there are only some types of contamination present, the steps of the process relative to elimination of the contaminating agents which are definitely absent can be omitted from the process, although the above-mentioned preset order must remain unchanged for the remaining steps.

[0020] A special automated station (Figure 4) controlled by programmable automatic control means - for example, a PLC - can allow, depending on the type of contaminating agent or agents, selection of the steps to be executed and selection of the starting step from which the ordered process must begin.

[0021] More specifically, eliminating contamination by organic substances (Figure 1) includes the application to the porous mould material of a liquid flow, consisting of an alkaline fluid, such as an alkaline solution which is a mixture of detergents and surfactants. The detergents are preferably of the cationic type rather than ionic, and the surfactants are selected in the alkyl ammino polyethoxylate group.

[0022] The diagram in Figure 1 also shows how practical elimination of contamination due to organic substances - symbolically labelled step A1 - involves continuously and repeatedly applying the alkaline solution in the mould until a control condition is satisfied, which allows recirculation of the solution to be stopped. A subsequent recirculation of a washing fluid, such as pressurised water - symbolically labelled step A2 - washes, rinses and removes from the mould the detergent solutions and the contaminants removed. Finally, a subsequent recirculation of a gaseous fluid, such as air, dries the pores of the material of which the mould is made.

[0023] The step of eliminating contamination caused by organic substances is followed by the part of the process in which the inorganic and biological contaminants (block B in Figure 3) are attacked.

[0024] Figure 2 in particular illustrates how basically this part of the process involves a first step of attack on the encrustations in an acidic environment - step B1, followed by a step of attack in an alkaline environment - step B3. Between steps B1 and B3 a disinfecting step in an alkaline environment is performed, labelled B2. Subsequent steps B4 and B5 involve a further treatment of the encrustations in an alkaline environment, whilst a step B6 performed at the end of the process allows further descaling in an acidic environment.

[0025] More specifically, the attack on inorganic encrustations in an acidic environment - labelled step B1 - involves the repeated application to the mould, through the relative drainage system, of a first fluid with acidic pH, for example a water-based solution or a mixture of one or more acids. Said solution preferably contains acid concentrations not exceeding 10% by weight and, if necessary, assisted by the presence of active agents in an acidic environment.

[0026] The most suitable types of acids and adjuvant agents are chosen taking into the account the chemical nature of the encrustations. For example, encrustations caused by ceramic mixtures can be treated effectively with hydrochloric acid, hydrofluoric acid, or mixtures of the two.

[0027] The disinfecting step in an alkaline environment - step B2 - may be performed by recirculating a washing fluid through the mould. Said fluid may be a washing solution containing biocidal agents compatible with the type of biological contamination in the mould.

For example, water-based solutions of sodium hypochlorite have a wide range of action, as strong biocides and disinfectants.

[0028] Both the disinfecting step B2 and the descaling step in an alkaline environment B3 can advantageously be combined with sequences involving the passage of compressed air through the mould.

[0029] The other steps of the process, represented by steps B4 and B5, are for descaling the pores of the mould material - the encrustations caused by ceramic mixtures - by washing with recirculation of an alkaline fluid, such as a water-based alkaline solution.

[0030] The solution, to which fluidifying agents are added, suitably chosen relative to the main substances in the encrustations, can also be combined with sequences of air blown through the mould. Examples of fluidifying agents suitable for ceramic mixtures are compounds such as polyphosphates and sodium and ammonium salts of polyacrylates with low molecular weight.

[0031] The further descaling step in an acidic environment - labelled B6 - involves successive repeated application to the mould of a washing fluid, preferably consisting of a water-based acidic solution, or mixtures of acids, up to a concentration of 20% by weight. The agents used may be the same as in step B1

[0032] Recirculation of water through the mould provides the final rinse of the pores of the mould material. Obviously, the process may involve the repetition, even partial, of one or more characteristic steps, as indicated - by way of example and without limiting the scope of the present invention - in Figure 2. Said figure illustrates how, after execution of step B6 and the subsequent step of washing with water, the drying steps may be repeated, steps B4 and B5 and the relative accessory washing and/or drying steps. Alternatively, it is possible to perform step B5 only, or even just repeat the washing and/or drying steps for the material of which the mould 2 is made. The cyclical repetition of the steps is kept active until a preset control condition is satisfied.

[0033] The mould regeneration station schematically illustrated in Figure 3 basically comprises a treatment tank 1, above which the moulds 2 to be regenerated are positioned. A ring-shaped pipe 3 with a pump 4 delivers the washing solutions arriving from suitable feed tanks 6a and 6b under pressure to the mould 2 drainage system. They are then taken from the tank 1 and recirculated, being sent to the mould 2 again. A system of intercepting means - such as solenoid valves 5 controlled by a PLC 7 - allows recirculation of the solutions used for mould 2 processing to be stopped, and allows them to be directed towards an outlet 8. Pipes 9, 10, 11, 12 connected to the ring-shaped pipe 3, also equipped with suitable solenoid valves 5 with switching controlled by the PLC 7, allow the pipe 3 which conducts fluids to the mould 2 to be filled with pressurised air and/or water, upon reaching the various characteristic steps of the process described.

[0034] As regards the methods for circulation of the liquid flows, during the process various alternatives are possible. A first option is provided by the possibility of introducing washing flows into the mould drainage system and having them flow out in the forming cavity through the porous screen, emptying them from the mould through the channels used to introduce and remove the slip. The washing flow is then circulated against the current, that is to say, in the direction opposite to that in which the ceramic mixture is introduced into the forming cavity.

[0035] An alternative option is provided by the possibility of circulating the washing flow with the current, for example, by applying washing solutions directly and locally on the forming surface, that is to say, on the surface of the filtering porous screen and with the aid of a vacuum applied to the mould in such a way as to produce the desired washing flow circulation.

[0036] The invention described can be used for obvious industrial applications. It can be subject to numerous modifications and variations without thereby departing from the scope of the inventive concept. Moreover, all the details of the invention may be substituted by technically equivalent elements.

Claims

1. A process for the functional regeneration of the porosity of the materials used to make moulds (2) for moulding ceramic objects, when the porosity has been damaged by use of the mould (2), the process being **characterised in that** it comprises the sequential execution of at least two successive steps of an ordered sequence which includes the steps of eliminating contamination caused by organic substances from the mould (2), eliminating contamination of biological origin from the mould (2), attacking inorganic encrustations present in the mould (2) and eliminating inorganic substances which have infiltrated the mould (2) pores, said process having a preset initial step which depends on the nature of a predetermined contaminating agent.

2. The process according to claim 1, **characterised in that** the step of eliminating contamination caused by organic substances includes the application (A1) of an alkaline flow to the porous material.

3. The process according to claim 2, **characterised in that** the alkaline fluid includes a solution containing a mixture of detergents and surfactants.

4. The process according to claim 2 or 3, **characterised in that** the alkaline fluid includes detergents selected from the cationic, not ionic group of detergents, and surfactants selected from the alkyl ammino polyethoxylate group.

5. The process according to any of the foregoing claims, **characterised in that** it comprises at least one mould (2) washing step (A2), using a washing fluid, following application (A1) of the alkaline fluid mixture of detergents and surfactants.

6. The process according to claim 5, **characterised in that** the washing fluid is water.

7. The process according to claim 5 or 6, **characterised in that** the washing step (A2) is carried out against the current relative to the direction in which the ceramic mixture is introduced into the mould (2) forming cavity.

8. The process according to claims 5 or 6, **characterised in that** the washing step (A2) is performed with the current, in the same direction as that in which the ceramic mixture is introduced into the mould (2) forming cavity.

9. The process according to claims 5 to 8, **characterised in that** the washing step (A2) is performed using pressurised water.

10. The process according to claims 5 to 8, **characterised in that** the washing step (A2) is performed by applying a vacuum to the mould (2).

11. The process according to claim 1, **characterised in that** the step of attacking the inorganic encrustations follows the step of eliminating the contamination caused by organic substances.

12. The process according to claim 11, **characterised in that** the step of attacking the inorganic encrustations is performed with a step (B1) of applying a first fluid with an acidic pH to the mould (2).

13. The process according to claim 12, **characterised in that** first fluid with acidic pH is a water-based solution.

14. The process according to claim 12 or 13, **characterised in that** the step (B1) of applying the descaling fluid is followed by washing with a suitable washing fluid.

15. The process according to claim 14, **characterised in that** the washing fluid is water.

16. The process according to claim 12, **characterised in that** the step of attacking the inorganic encrustations is achieved by recirculating the fluid with acidic pH through the mould (2) drainage system.

17. The process according to claim 13, **characterised in that** the descaling fluid comprises a water-based solution of at least one acid.

18. The process according to claim 17, **characterised in that** said acid or each acid in the water-based solution does not exceed a concentration of 10% by weight.

19. The process according to any of the foregoing claims from 12 to 18, **characterised in that** the solution includes hydrochloric acid.

20. The process according to any of the foregoing claims from 12 to 19, **characterised in that** the water-based solution includes hydrofluoric acid.

21. The process according to claim 1, **characterised in that** the step of attacking the inorganic encrustations includes at least one further step (B3; B4, B5) of applying an alkaline fluid to the mould (2).

22. The process according to claim 21, **characterised in that** the step of attacking the inorganic encrustations includes at least one further step (B3; B4, B5) of applying the alkaline fluid after the step (B1) of applying the first fluid with acidic pH.

23. The process according to claim 21 or 22, **characterised in that** it comprises a step of washing the mould (2) with a washing fluid, following the step (B3; B4, B5) of applying the alkaline descaling fluid.

24. The process according to claim 23, **characterised in that** the washing fluid is water.

25. The process according to claim 23 or 24, **characterised in that** it comprises at least one step of passing a pressurised gaseous flow through the mould (2), following the step (B3; B4, B5) of applying the alkaline descaling solution.

26. The process according to any of the foregoing claims from 22 to 24, **characterised in that** the attack on inorganic encrustations is performed by recirculating the alkaline fluid through the drainage system.

27. The process according to claim 26, **characterised in that** it comprises sequential applications of a gaseous flow, following the step (B3; B4, B5) of applying the alkaline fluid.

28. The process according to claim 1, **characterised in that** the descaling fluid is applied using pressurisation.

29. The process according to claim 1, **characterised in that** the descaling solution is applied using a vacuum.

30. The process according to any of the claims from 11 to 28, **characterised in that** the step of attacking the inorganic encrustations is performed by means of a step (B6) of applying a second fluid with acidic pH to the mould (2).

31. The process according to claim 30, **characterised in that** the second fluid with acidic pH comprises a water-based solution of acids or mixtures of acids whose concentrations do not exceed 20% by weight.

32. The process according to claim 31, **characterised in that** it comprises the application to the mould (2) of active adjuvants in an acidic environment.

33. The process according to any of the foregoing claims, **characterised in that** the steps include the transfer through the mould (2) of substances moved against the current relative to the direction in which the mixture which will form the ceramic object is introduced into the mould (2).

34. The process according to claim 33, **characterised in that** the steps include the transfer in the mould (2) of substances moved with the current relative to the direction in which the mixture which will form the ceramic object is introduced into the mould (2).

35. The process according to claim 1, **characterised in that** the operating steps are controlled by automatic control means (7), being programmable according to the type of contaminants of the porosity of the material used to make the mould (2).

36. An operating station which implements the regeneration process in accordance with the foregoing claims.

37. The station according to claim 36, **characterised in that** it comprises: a tank (1), above which the moulds (2) to be regenerated are positioned; a pipe (3) equipped with a pump (4) through which the washing fluids from at least one tank (6a; 6b) are delivered to the mould (2), the fluids then being taken from the tank (1) and recirculated through the mould (2); a system of intercepting means (5) controlled by the automatic control means (7) allowing recirculation of the fluids to be controlled and allowing them to be directed towards an outlet (8) when a preset control condition is satisfied.

38. The station according to claim 37, **characterised in that** the station comprises at least one pipe (9; 10; 11; 12) connected to the pipe (3) which is connected to the mould (2), the pipe having intercepting means (5) which can be switched on command and which are controlled by the automatic control means (7), allowing the fluids selected according to characteristic steps of the regeneration process to be delivered to the pipe (3) which conducts fluids to the mould (2).

FIG.1

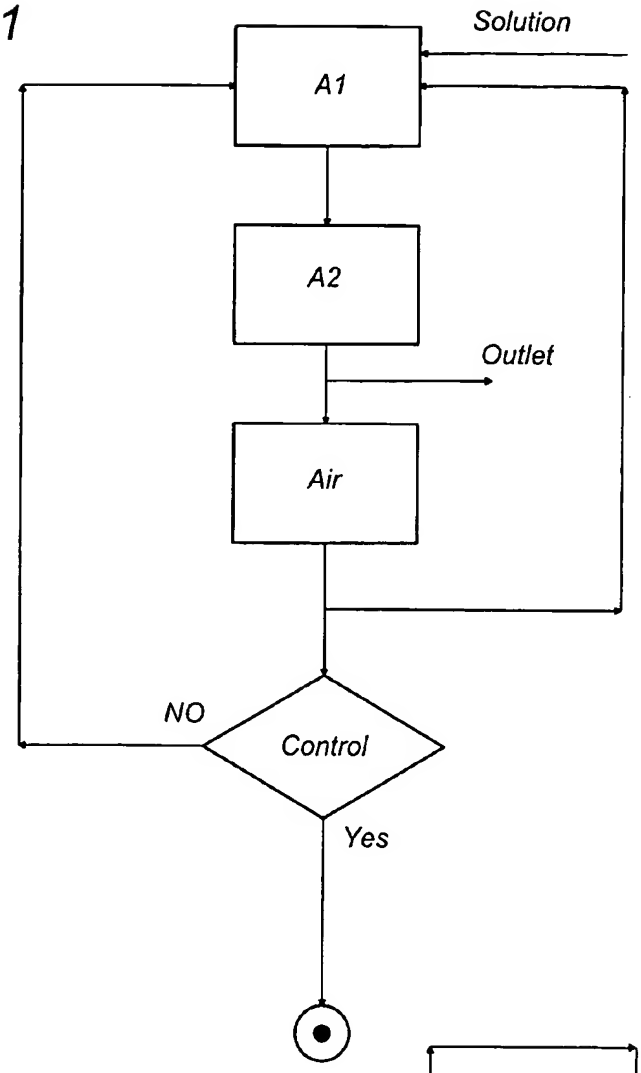


FIG.3

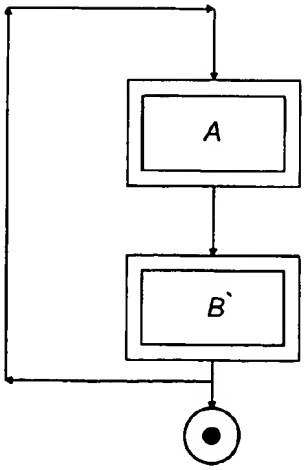
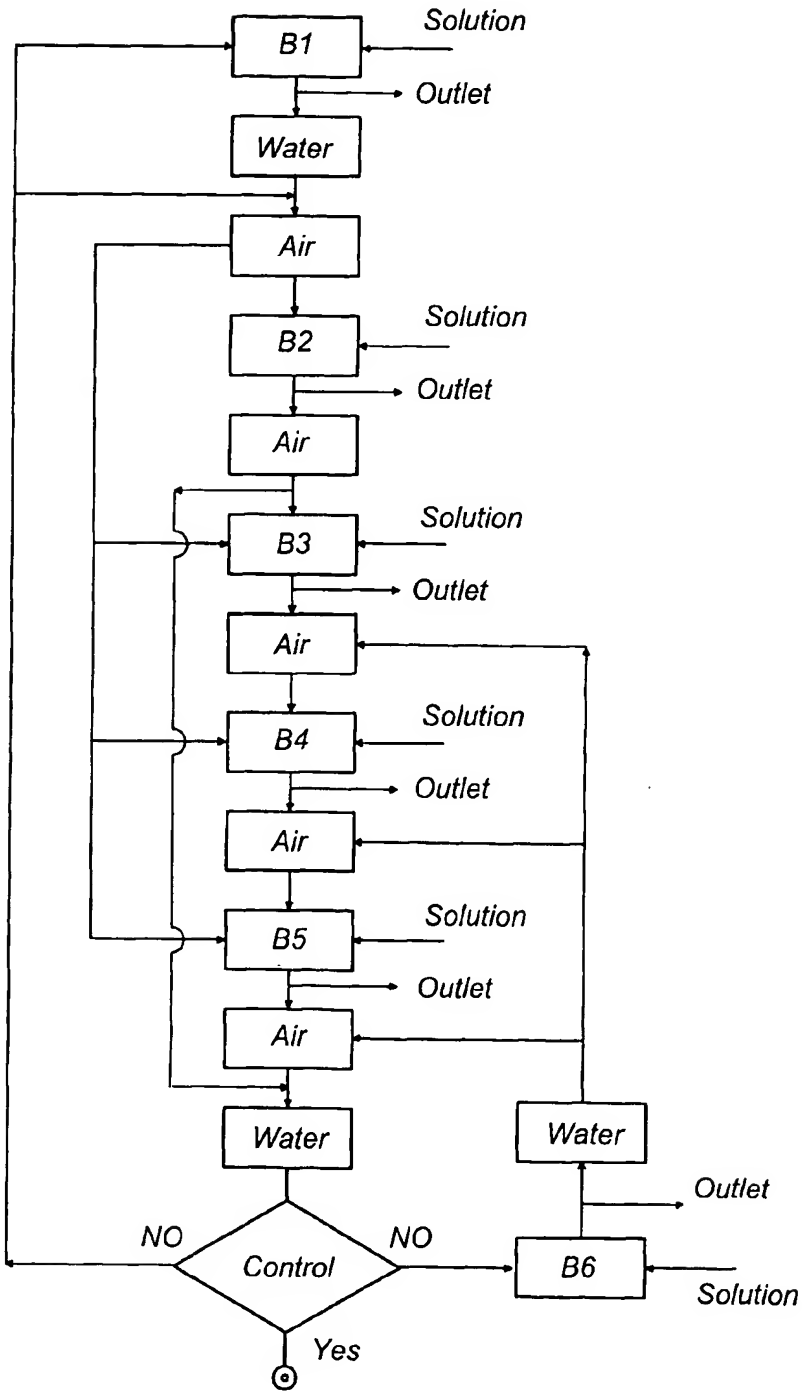


FIG.2



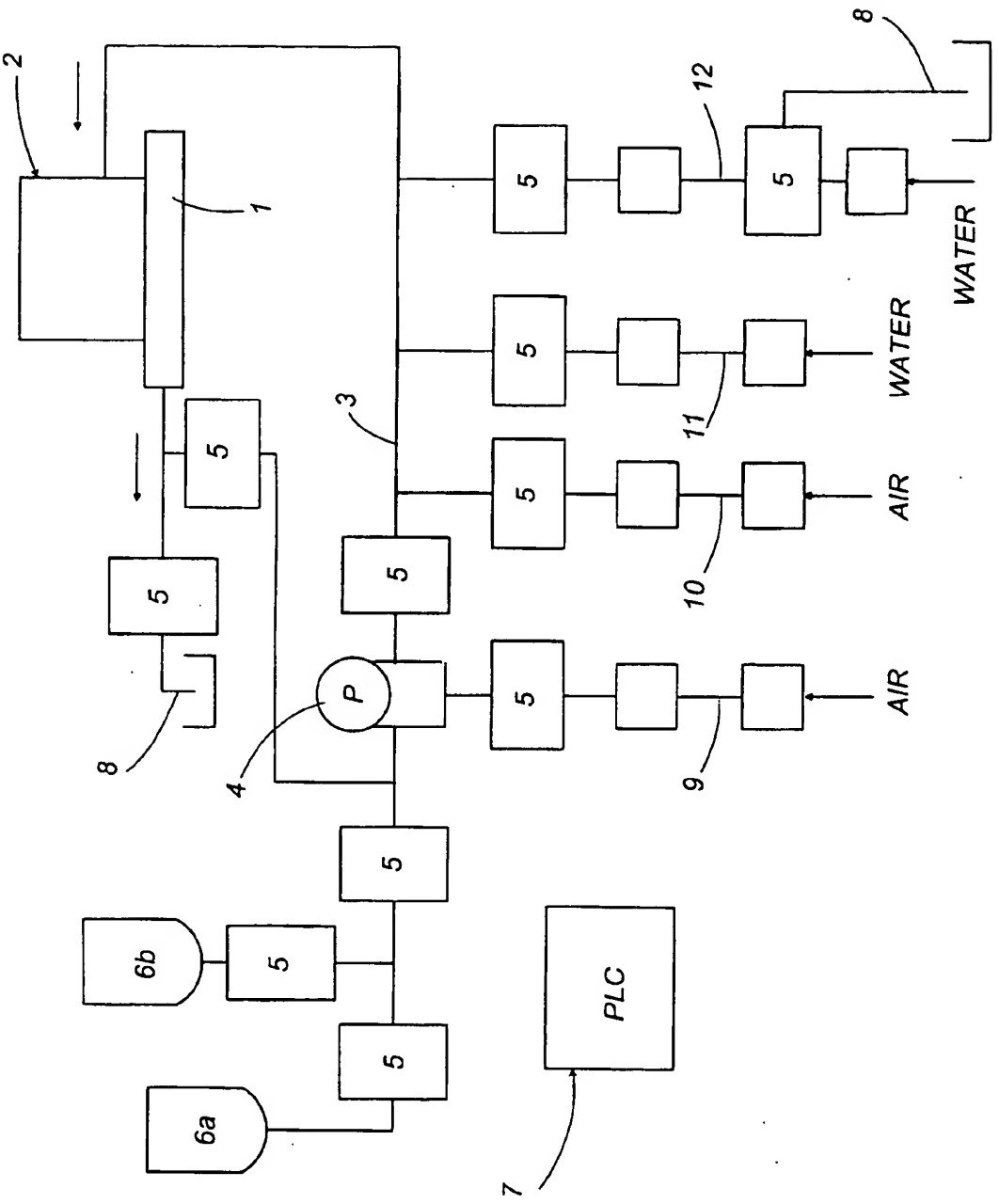


FIG.4

European Patent Office

PARTIAL EUROPEAN SEARCH REPORT

which under Rule 45 of the European Patent Convention shall be considered, for the purposes of subsequent proceedings, as the European search report

Application Number EP 01 83 0325

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	EP 0 463 179 A (KAWASAKI STEEL CO ;SHIN EI KIKO CO LTD (JP)) 2 January 1992 (1992-01-02) * page 6, line 11 - line 47 * * claim 2; figures 6,7 * ---	37,38	B28B7/38
A	DE 21 07 018 A (KERAMAG) 24 August 1972 (1972-08-24) * page 5, last paragraph - page 6, paragraph 1 * -----	37	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

B28B

INCOMPLETE SEARCH

The Search Division considers that the present application, or one or more of its claims, does/do not comply with the EPC to such an extent that a meaningful search into the state of the art cannot be carried out, or can only be carried out partially, for these claims.

Claims searched completely :

Claims searched incompletely :

Claims not searched :

Reason for the limitation of the search:

see sheet C

Place of search	Date of completion of the search	Examiner
THE HAGUE	16 January 2002	Orij, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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European Patent Office

INCOMPLETE SEARCH SHEET C

Application Number
EP 01 83 0325

Claim(s) searched completely:
37,38

Claim(s) not searched:
1-36

Reason for the limitation of the search:

Present claims 1-35 relate to an extremely large number of possible methods. It is not clear if the "two successive steps" in the first claim are the same as the various "steps" later claimed. Further the claim contains so many possible permutations, that a lack of clarity (and conciseness) within the meaning of Article 84 EPC arises to such an extent as to render a meaningful search of the claims impossible.

Present claim 36 relates to an apparatus defined by reference to a desirable characteristic or property, namely implementing a regenerating process. The claims cover all apparatus having this characteristic or property, whereas the application provides support within the meaning of Article 84 EPC and disclosure within the meaning of Article 83 EPC for only a very limited number of such apparatuses. In the present case, the claims so lack support, and the application so lacks disclosure, that a meaningful search over the whole of the claimed scope is impossible. Independent of the above reasoning, the claims also lack clarity (Article 84 EPC). An attempt is made to define the apparatus by reference to a result to be achieved. Again, this lack of clarity in the present case is such as to render a meaningful search over the whole of the claimed scope impossible. Consequently, the search has been carried out for those parts of the claims which appear to be clear, supported and disclosed, namely claims 37, 38.

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 01 83 0325

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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16-01-2002

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82